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# Fish bladder-based activated carbon/Co<sub>3</sub>O<sub>4</sub>/TiO<sub>2</sub> composite electrodes for supercapacitors

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## Abstract

Cobalt oxide/titanium dioxide/activated carbon (Co<sub>3</sub>O<sub>4</sub>/TiO<sub>2</sub>/Ac) composite was synthesized using simple sol-gel method before annealing at 300 °C. Fish bladder derived porous carbon used for the composite was synthesized by pyrolysis followed by chemical activation. Both scanning electron microscopy (SEM) and X-ray diffraction displayed Co<sub>3</sub>O<sub>4</sub> and TiO<sub>2</sub> phases well embedded onto the carbon matrices. Cyclic voltammetry in 6 M KOH electrolyte demonstrated that the composite has an excellent specific capacity of 946 Fg<sup>-1</sup> for Co<sub>3</sub>O<sub>4</sub>/TiO<sub>2</sub>/Ac as compared to Co<sub>3</sub>O<sub>4</sub>/Ac, TiO<sub>2</sub>/Ac, and Ac with specific capacitances of 845, 340, and 308 Fg<sup>-1</sup>, respectively at 5 mVs<sup>-1</sup>. Impedance spectroscopy reveals that the composite has good capacitive behavior with a series resistance of 0.6 Ω. Besides, Co<sub>3</sub>O<sub>4</sub>/TiO<sub>2</sub>/Ac maintains 89.7% of the initial capacitance after 2000 cycles. This study shows that the synergistic effect of the metal oxides and the carbon in the composite can enhance capacitance for practical supercapacitor applications.

## Keywords

Fish bladder activated carbon; Supercapacitor; Specific capacitance; Cobalt oxide; Titanium dioxide